

A Condensed Summary of the Science behind the Skagit River Basin Water Management Rule and the 2006 Amendment

Ecology is required to set minimum instream flows as per RCW 90.22 *Minimum Water Flows and Levels*, and RCW 90.54.020(a) of the *Water Resources Act of 1971*. As such, Ecology establishes instream flow rules for the major river basins of the state. The purposes of these flows are to protect instream resources including fish and wildlife habitat, water quality, and recreation, plus protect senior water right holders.

In 1994, efforts began to correlate future estimated out-of-stream water uses in the Skagit River system and their impacts on resident and anadromous fish populations. Initial efforts were spearheaded by Skagit PUD, while they were attempting to acquire new water rights in the Cultus Mountains. However, other organizations were involved within a short time.

The City of Anacortes (Anacortes), Skagit County, the Upper Skagit Indian Tribe (Upper Skagit), the Swinomish Indian Tribal Community (Swinomish), the Sauk-Suiattle Indian Tribe (Sauk-Suiattle), the Washington Department of Ecology (DOE), and the Washington Department of Fish and Wildlife (DFW), and Skagit PUD agreed that an instream flow rule was necessary for the future of water management in the Skagit River Basin. The Skagit Instream Flow Committee was formed with representatives from each of these organizations.

There are a variety of different scientific methods used to determine such flows, which all focus on fish needs. In the United States, fish needs are considered to be the best indicator of river health, so generally, other instream resources thrive when fish thrive. In Washington, an instream flow rule is typically based on the stream flows needed to support healthy fish populations. The method that was chosen for the Skagit watershed is known as the Instream Flow Incremental Methodology (IFIM). The U.S. Fish and Wildlife Service developed IFIM in the 1970s, and it is one of the most rigorous and accepted methods used throughout the country. Skagit PUD and the City of Anacortes hired an independent consultant, Duke Engineering, to conduct the study. After a detailed reconnaissance of the Lower Skagit watershed, Duke Engineering decided to use different methods for different parts of the watershed. Duke Engineering and its predecessor, Cascade Environmental Services (CES), conducted IFIM studies in the Mainstem of the Skagit River and in the Cultus Mountain tributaries, while they used another method in the Skagit Estuary.

The Skagit Mainstem IFIM Study

IFIM is a series of computer-based models which calculate how much fish habitat you gain or lose as you increase or decrease stream flow. It is based on the understanding that fish prefer water with a certain depth or velocity. The models recognize that these preferences vary for different species, and for different stages of a fish's life in a river. This method requires significant field research into stream morphology, fish presence and behavior, and flow measurements at different locations during low, medium, and high flows. IFIM uses depth, velocity, substrate, and cover as variables, which are key measurements for determining instream flow numbers. At certain flows, such as extreme low flows, other variables such as food supply and predators may be a greater importance to fish survival and production.

Information regarding site-specific stream flow and habitat data was collected by Duke Engineering in the field and then inputted into a group of models collectively called PHABSIM (**Physical HABitat SIMulation**). PHABSIM is still the most commonly used hydraulic modeling program within IFIM to predict depths and velocities across designated stream transects as a function of discharge.

The resulting model for the Skagit River quantified habitat availability over a range of flows for the specified salmonid species at different life stages. The end result was an index of habitat suitability called the Weighted Useable Area (WUA) that gave the amount of habitat in square feet per 1,000 linear feet of stream for each species and life stage. (See Figures 5.1-1 and 5.1-2.) Once the WUA was established, a fish periodicity chart was prepared showing when the different species and life stages occur in the river. Finally, a stream hydrology analysis was done to show water levels at various times of the year.

Based on this information and after extensive discussion, the Skagit River Instream Flow Committee recommended a set of stream flow numbers based on this work. These were the Skagit Main Stem

Instream Flow values ultimately adopted by Ecology in the final Skagit River Basin Water Management Rule.

The Cultus Mountain Tributary Studies

Similarly, Duke Engineering (formerly CES) used IFIM in three Cultus Mountain Tributaries (Gilligan, Turner, and Mundt Creeks) to calculate how fish habitat changes in a stream when stream flow changes. These results were reported to members of the Cultus Tributaries instream Flow Committee. Members included DFW, DOE, the Skagit System Cooperative (representing the Sauk-Suiattle and the Swinomish), and Skagit PUD.

CES conducted these studies before Lower Skagit Mainstem IFIM study and the Estuary Study. These studies also examined what water, if any, was available for additional appropriation in these tributaries. Based on this information, CES generated a set stream flow numbers for each of these tributaries to the committee that varied throughout the year.

The Instream flow numbers set for Salmon Creek are an exception. During the time of the IFIM studies, an excavation project prevented CES from conducting an IFIM study that was representative of Salmon Creek. Therefore, an IFIM study was not performed in time for participants to discuss the results. Instead, Cultus Mountain participants used information from previous Toe-width and synthesized stream flow calculations to make recommendations. While not as rigorous as IFIM, toe width studies are also used in Washington State as the scientific basis for flow numbers in instream flow rules.

After a year and a half of discussion, the Cultus Tributaries concluded discussion of these studies, and arrived at instream flow numbers for each of these tributaries there were ultimately included adopted as part of the Skagit River Basin Water Management Rule.

The Estuary Study

Duke Engineering and the Skagit River Instream Flow Committee recognized that one of the most critical areas for fish in the Skagit system was the Skagit estuary. Estuaries act as nutrient traps where river-born organic and inorganic materials collect in concentrated amounts. This makes estuaries prime rearing habitat where juvenile salmonids can voraciously feed to increase in size before migrating out to sea. However, unlike in riverine areas, there is no universally recognized model like PHABSIM to characterize and quantify potential available habitat. PHABSIM cannot be used because such studies predict the habitat values of depth, velocity, substrate, and cover as a function of only river discharge. Estuaries like those in the Skagit are tidally influenced, therefore the depth of water, velocity, and direction of stream flow are affected not only by surface water runoff and ground water inflow, but also ocean tides. To address this difference, Duke Engineering created a methodology, encompassing the IFIM's conceptual approach, that established a relationship between freshwater discharge and Water Surface Elevation (WSE) in selected estuary channels and associated tidal marshes during both tidal and non-tidal periods. Using WSE as the link, Duke Engineering modeled estuary hydrodynamics and potential salmonid habitat availability as a function of river discharge. Coupled with channel geometry and the relationship between channel WSE, river discharge, and tide, the study method provided a tool that predicted the relationship between river discharge and a number of hydrodynamic and physical habitat parameters related to water surface elevation. In addition, this method provided a means of determining when the tide level low enough so that WSE is only a function of discharge (non-tidal period).

With the results of this work, the Skagit River Instream Flow concluded that a 10% maximum threshold was a reasonable level to set for significant impacts, which is a maximum allocation of 836 CFS. After further discussion, the committee recommended 836 CFS as the maximum allocation of water from the lower Skagit River between the months of February through August.

This recommendation is also included in the Skagit River Basin Water Management Rule.

Recommendations to Committee

The instream flow laws direct that stream flows be set at a level that protects and preserves fish habitat. This drives policy decisions that set instream flow levels. In the Skagit River Basin Water Management Rule, Ecology set instream flows so high, that they aren't always met. It seems excessive, but setting higher instream flows prevents further allocation that could negatively impact fish habitat during dry and

average years. As the two graphs below demonstrate, optimal flows for rearing and spawning fish at the Mount Vernon Gage mostly fall within the range of 10,000 to 15,000 cubic feet per second of flow .

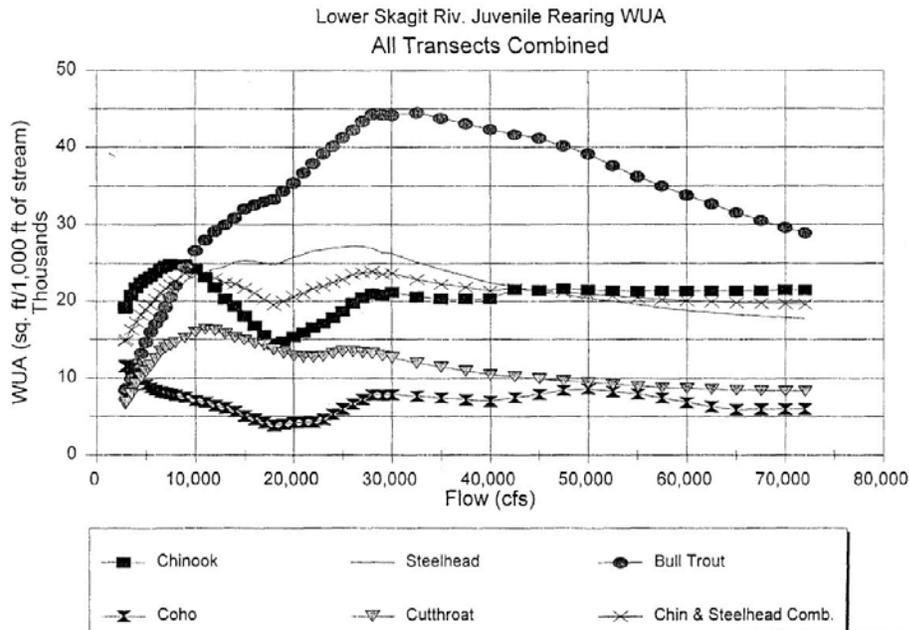


Figure 5.1-1

Flows too slow,
depth too shallow

Flows too fast and
depth too deep

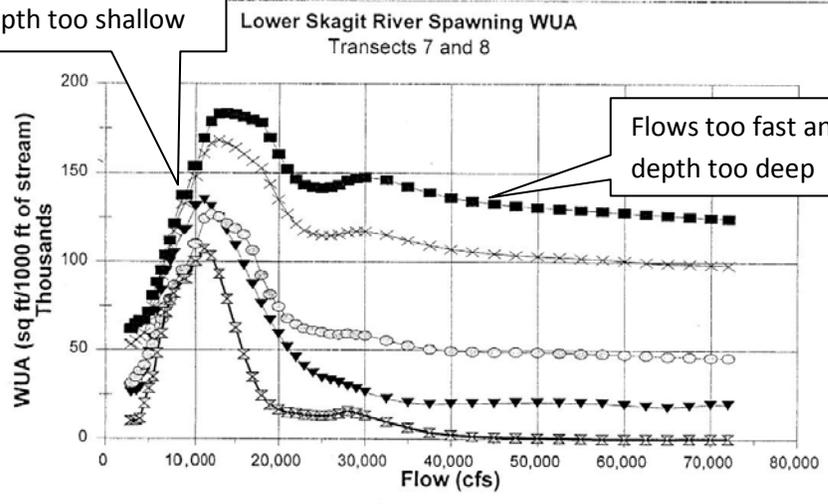


Figure 5.1-2

Part 2: A Summary of the 2006 Department of Ecology Skagit River Basin Water Management Rule Amendment

Report Summary: Ecology's "Rule Making Criteria: Background on the Reservations, Closures and Hydraulic Continuity Report" May 2006.

The reservations established in 2006 as part of the Amendment of WAC 173-503 *Instream Resource Protection Program – Lower and Upper Skagit Water Resource Inventory Area (WRIA) 3 & 4* were composed of 3 separate reservations that would not be subject to the Skagit River Basin Water Management Rule. The purpose of the reservations was to establish an uninterrupted supply of water available for out-of-stream needs in the Skagit River Basin. These reservations were defined as follows:

- A reservation of approximately 14.5 cubic feet per second (cfs) was reserved for domestic, municipal, and commercial/industrial uses. This reservation was divided among 25 separate sub basin areas within the Skagit River basin.
- A reservation of approximately 10 cubic feet/sec (cfs)^[1] was reserved for agriculture irrigation purposes.
- A reservation of approximately 0.5 cfs was reserved for stock watering purposes.

(Please Note: the 2006 Amendment was invalidated on Oct 3, 2013 by the Washington State Supreme Court in Swinomish Indian Tribal Community vs. Ecology.)

The importance of base flow and the potential impact of groundwater withdrawals

A significant portion of stream flow in the Skagit Basin is dependent on base flow, or ground water recharge, especially during late summer months in tributary sub-basins. For example, base flow was estimated to represent 80-98% of stream flow in Alder Creek, 41-66% of stream flow in Day Creek, and 55-72% of stream flow in Tank Creek during the months of July-September. This information was based on flow data collected over decades. Therefore, groundwater withdrawals from wells can have a significant potential impact on surface water sources during critical times of the year.

With this in mind, the reservations were designed to have a very small impact to the long term sustainability of the fish population in the Skagit and were considered very protective of fish while providing for out-of-stream needs.

Determining the size of reservations

The size the reservations were limited to amounts that Ecology and Department of Fish and Wildlife (WDFW) fish biologists believed were unlikely to significantly impact the long term sustainability of migratory and resident fish populations. Biologists from Ecology, in consultation with the WDFW, determined that the reservation withdrawals would cause a habitat loss of 0.5% to 2% during a bad case scenario such as during a low flow month like September during a low flow year. This percentage loss would be much smaller during the other months of the year when higher flows exist. These numbers are based on an established high correlation between stream flows, habitat and fish population. Numerous

studies since the 1940's have demonstrated that the higher the 30 or 60 day low summer flow (August-September), the higher number of returning adult salmon. The results from one such study done by F. W. Olson in 1983 for the South Fork Skokomish River is shown at left, showing the relationship between the size of the Puget Sound Coho Run and low Summer Flows.

The impact of reservations on fish habitat

A habitat loss of 1 to 2% was calculated on other streams in Washington State where Instream Flow Incremental Methodology /Physical Habitat Simulation

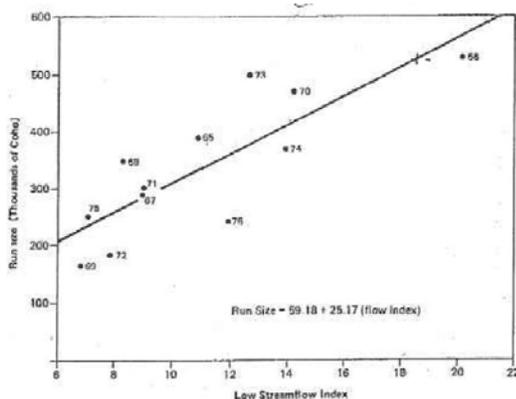


Figure 3-8
Relationship between
Puget Sound Coho Run
Sizes and Summer Low Flow

s per minute.

(IFIM/PHABSIM) fish habitat studies were performed. Ecology biologists found that a 1%-2% loss in habitat closely corresponds with a 1%-2% loss in stream flow during low flow conditions. Therefore, a 1% to 2% loss in stream flow during a low stream flow month such as September can serve as a reasonable surrogate for estimating the 1% to 2% loss in fish habitat in the Skagit River Basin.

7Q10 as a Measure of Low Stream Flow Conditions

Based on the relationship of stream flow to fish habitat, Ecology used a flow statistic known as 7Q10 as representative of low stream flow conditions in the tributary sub basins. 7Q10 is the lowest consecutive seven day stream flow to occur an average of every 10 years (in other words, flow duration at a particular interval, the longer the interval, the greater likelihood of having lower recorded flows). This is generally comparable to a 90% exceedence flow (a low stream flow that is exceeded 90% of the time over a 10 year interval). The 7Q10 is representative of a significant, longer dry spell than usual which would take months to develop and would have significantly longer-term environmental and economic impacts beyond the low flow duration. Ecology considered 2% of the 7Q10 flows to be the upper limit of an acceptable reservation size when determining the reservation quantities. Since sub-basin specific flow data didn't exist where Ecology intended to implement reservations, Ecology's calculated synthesized flows for each subbasin. Scientists can calculate what an average range of stream flows might be for a watershed by using stream flow data from a similar watershed. This is what is known as a synthesized flow calculation. In Ecology's calculations, the most important criteria for determining correlation between gauged basins and un-gauged basins were similar trends in drainage area and precipitation (mean annual precipitation). The USGS has also used this approach in the statistical regression analysis of high flows for in other parts of Washington State.

Low flows are considered to represent groundwater inflow into the streams (base flow). These base flow conditions occur sometime after the last significant precipitation and surface runoff. Therefore, watershed geology, soil type, land uses, slope, and proximity between basins were also considered when determining the relation of gauged to un-gauged watersheds. In assigning specific quantities of the reservations to each basin based on 2% of the 7Q10, Ecology used a metric called Cubic Feet/second to Square Mile (cfs/square mile) or CSM. This is the total amount of instantaneous flow per total area of the basin.

Notes on the Agricultural Irrigation Reservation

The agricultural irrigation reservation was limited to only the Mainstem sub-basins (Upper, Middle, and Lower Skagit). This reservation was sized to stay below the 1-2% stream depletion threshold, as previously discussed, and was also shaped by assessing future agricultural irrigation demand. Irrigation water rights are typically seasonal rights used during the irrigation growing season. In Western Washington, for crops that are typically grown in this region, the irrigation season is typically defined in water rights for the months of April- October, approximately 180 days. The irrigation season is the authorized period of use for the water, and it is unlikely that an irrigation water right holder would use water throughout this period. The agricultural reservation was 3,564 acre feet per year. This figure was derived by assuming 10 cfs diverted continuously throughout the irrigation season.

The quantities authorized under the water right were based on the physical capacity to withdraw water and the projected irrigation need. According to water demands for typical crops grown in the Skagit Basin, the average water duty for crops grown in the Skagit Basin is approximately 1.5 acre feet per acre. Based on these assumptions the agriculture reservation of 3,564 acre feet per year would cover an additional 2,376 acres.

Conclusion of 2006 Amendment Summary

Please note that this approach for determining reservation quantities is not as rigorous as is currently possible. A more detailed analysis including more sophisticated modeling would improve accuracy. Sub basin instrumentation for precipitation and stream flow would also have provided more definitive flow estimates. However, such data collection and modeling would take significant resources, especially if studies were performed at each sub basin. Also, it is unknown whether the results would significantly differ from the reservation values created by the conclusions of the existing approach.

The above method of determining suitable reservation amounts was independently peer reviewed by Geomatrix Consultants. Additional information and recommendations provided by Geomatrix's review were incorporated in the final report as was deemed appropriate.

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